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INSTRUCTOR PILOT'S ROLE IN SIMULATION TRAINING (PHASE II).(U)

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Technical Report NAVTRAEQUIPCEN 76-C-0034-1

INSTRUCTOR PILOT'S ROLE IN SIMULATION TRAINING (Phase II)

APPLI-MATION, INC.
Orlando, Florida 32803

FINAL REPORT MARCH 1976 - MAY 1977

August 1977

DoD Distribution Statement

Approved for public release; distribution unlimited.

NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NAVTRAEQUIPCEN 76-C-0034-1	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Instructor Pilot's Role in Simulation Training (Phase II)	5. TYPE OF REPORT & PERIOD COVERED: Final Report, Mar 76- May 77
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Dr. John P. Charles	8. CONTRACT OR GRANT NUMBER(s): N61339-76-C-0034
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Appli-Mation, Inc. 930 Woodcock Rd., Suite 111 Orlando, FL 32803	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NAVTRAEQUIPCEN TASK NO. 5751-1P1A
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Training Equipment Center Orlando, FL 32813	12. REPORT DATE: August 1977
	13. NUMBER OF PAGES: 57
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
12 55p.	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Simulator Training
Instructor Pilot
Simulator Operator
Instructor Console

(AD - A023 546).

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Analyses of Instructor Pilot functions in training pilots using simulation were performed. The functions were based on the review of current simulation training conducted in the Phase I study NAVTRAEQUIPCEN 75-C-0093-1. Feasible allocations of functions were made and modular implementation concepts developed.

SUMMARY

The first phase of the study of the Navy Instructor Pilots' Role in the use of flight simulators in fleet pilot training was concerned primarily with reviewing current training operations and training simulators. The report revealed that significant changes have occurred in recent years in terms of instructor personnel and equipment. Most important was the conclusion that simulator instructor consoles are not designed for training implementation and that the IP is neither trained in simulator utilization or in "how to instruct." The problems were further compounded by the lack of well defined simulator training syllabi and supporting documentation.

The second phase of the study has involved the development and detailed analysis of the IP functions in simulator pilot training. In addition, the interaction of the Navy Flight Officer Instructor was analyzed.

A total of ten functions involving 35 sub-functions was structured. A conceptual console of nine modules which could support these functions was outlined. The interaction and relationship of the Navy Flight Officer Instructor and the IP were explored for those weapon systems in which an NFO is part of the aircrew.

While the conceptual console module appears to be technically feasible, some laboratory demonstrations and field testing should be conducted before the detailed specification is written.

FOREWARD

This is the second report of Project 5751, "The Instructor Pilot's Role in Simulator Training." In it, the analysis of Instructor Pilot's functions in simulator training and a conceptual plan for the design of the instructor's console are described.

In a third report, the specification for a candidate design of the instructor's console will be presented. This design will be evaluated experimentally under other Advanced and Engineering Development efforts.

Vincent J. Sharkey
VINCENT J. SHARKEY

PREFACE

The value of the results of any analysis is contingent upon the quality of the data which are input. This is particularly true when dealing with operational data. Therefore, whatever success has been achieved must be credited to the many officers and men in the training squadrons and staff who devoted time and effort to provide the data utilized in the study. In particular, the efforts of the following personnel should be recognized.

Mr. James Bolwerk - Commander Naval Air Force United States Pacific Fleet Staff, who arranged and coordinated the West coast visits, and who provided insight into many problem areas.

Mr. R. Goodwin - Commander Naval Air Force United States Atlantic Fleet, who coordinated the East coast visits.

The Officers-in-Charge of the Fleet Aviation Specialized Operation Training Group Detachments and their staffs who provided the data on simulation operations, answered questions and assisted in our observation of on-going training.

The operation and training staffs of the Readiness Training Squadrons who helped isolate the data required, completed questionnaires, and described training evolutions and problems.

Finally, special appreciation is expressed to Mr. V. Sharkey, project Technical Representative who provided insight into problem areas and arranged the contacts with fleet personnel.

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SECTION I

INTRODUCTION

BACKGROUND

The integration of the simulator instructor(s) into the simulation instructional system represents a major design task. As with other man-machine interface problems, it has frequently received inadequate attention. Unfortunately because of the central role played by the instructor in training systems, the result has directly affected the effectiveness of the devices and training costs.

Recognizing that the rapid advances in both simulation and training methodology were also impacting on the simulator interface design problem, the Human Factors Laboratory of the Naval Training Equipment Center (NTEC) undertook a program to define the instructor console requirements for future devices. The overall program was directed to the development of data in four areas, namely:

a. The role of the Instructor Pilot (IP) and the Simulator Operator (SO) in the use of flight simulators as an integral part of the system for training pilots.

b. The design of the IP/SO consoles.

c. The degree to which hardware components might be standardized.

d. The possibility of using the instructor console for training the instructor pilots.

PHASE I STUDY

A multi-phase approach was taken. The first study[1] was primarily directed to:

a. Defining the role of the Instructor Pilot and Simulator Operator in simulator supported pilot training.

b. Specifying the training goals of the instructor(s) in

[1]Charles, John P., Willard, Gene and Healey, George. "Instructor Pilot's Role in Simulation Training", Tech. Report NAVTRAEQUIPCEN 75-C-0093-1, Naval Training Equipment Center, Orlando, Florida, March 1976.

terms that could be used for functional design of feasible consoles to the basic objectives of the program.

Data were gathered from all of the Navy Readiness Training Squadrons (RTS) and included identifying the role of the IP in current simulation and his training for that role. Simulators under development were also reviewed.

The results, in general, revealed that:

- The IP has assumed the role of simulator instructor in recent years.

- The role of the IP (and SO) varies with the type of simulator, weapon system and type of training involved.

- The IP (and SO) are not trained to instruct on simulators, either in simulator operation or methods of instruction.

- Simulator syllabi are not designed to simulator training requirements.

- Instructor consoles are not designed for IP use.

- The Navy Flight Officer's (NFO) role in simulator instruction interacts with the IP's role and must be considered in console design.

- Modular consoles appear feasible.

In short, the simulator instructor for pilot training is typically untrained for that job, is not provided essential information for the task, (e.g., syllabi, scripts, and scenarios) and is expected to perform at a console not designed for the job.

The study also developed a basic instructor pilot function flow for the generic role identified.

SECTION II

PROBLEM

GENERAL

A review of the background of the problem was presented in the final report for Phase I. In brief, the role of the simulator instructor for pilot training has evolved from the early non-pilot specialist to the current instructor pilot concept. Unfortunately, console design has not evolved similarly. When coupled with a general lack of training in simulator utilization, the problem facing the current instructor pilot is obvious and certainly not trivial. As outlined in the first report, the result is not only an ineffective use of simulation in the training program, but a general dislike and distrust of the technique as a training tool. Although exceptions do exist and steps are being taken to ameliorate the problem, the Instructor Pilot problem exists throughout the pilot readiness training program. A major factor, which is the subject of this study program, is the poor design of the interface between the instructor and the rest of the simulator training system, especially the instructor's console.

PHASE II STUDY

The report on the first phase study described the flight simulator instructor(s) role in current and projected readiness pilot training. Basic instructor functions were developed. The second phase effort was, therefore, concerned with a detailed analysis of these functions. A review of the NFO Instructors (NFOI) role in pilot training was also conducted to ensure that the functional specification reflected this interaction. Thus, the basic problem addressed in this study was the analysis and documentation of instructor pilot functions in simulation training.

SECTION III

METHOD

GENERAL

The basic systems engineering approach utilized in the first phase was continued in this phase. A set of five tasks was utilized to conduct the analyses and to develop the functions. These tasks were:

Task A Function Analysis

Task B Design Analysis

Task C Alternative Analysis

Task D Specification Development

Task E Documentation

In addition the first task included the review of the NFOI interaction problem. All of the tasks considered the console requirements outlined in the Phase I report, which transcends IP requirements, including the feasibility of peer and "self-training" concepts.

TASK A. FUNCTION ANALYSIS. A detailed analysis of the functions identified in the first phase was conducted. The functions were structured so that they reflected the different philosophy and implementation requirements imposed by console location, e.g., integral with or isolated from the student(s) station, and the different training objectives and requirements of the Readiness Training Squadron and the Fleet Operational Squadrons. The analyses were carried to the point of identifying basic decision functions and information requirements.

TASK B. DESIGN ANALYSIS. The second task was directed toward preliminary allocations of functions and development of modular design concepts.

TASK C. ALTERNATIVE ANALYSIS. The concepts developed in Task B were analyzed in terms of the criteria (IP's role) developed in the Phase I report as well as in terms of state-of-the-art of console design and training technology. The objectives were directed toward the next generation of trainers in terms of design. However, consideration was also given to the retrofit problems for key functions, i.e., those which would produce a significant training-cost benefit if implemented on current trainers.

TASK D. TRADE-OFF ANALYSIS. Broad trade-offs of conceptual feasibility and effectiveness were attempted. The objective was to identify attractive alternatives and to structure risk areas for further study.

TASK E. DOCUMENTATION. The final task was the preparation of the final report.

REVIEW AND VALIDATION

Visits were made to the major readiness training squadrons to both confirm the function definition data and to explore the NFOI interaction problem and requirements. In addition, data on late developments in the 2F-106, 2F-112 and 2F-114 projects were reviewed. The latest Instructional Systems Development (ISD) data for the SH-2, A6E, E-2C and F-14 were also reviewed.

SECTION IV

RESULTS

GENERAL

The findings and results will be reviewed under four topics:

(1) Function Breakdown

(2) Function Allocation

(3) NFOI Interaction

(4) Module Concepts

The data collected and analyzed in the Phase I study served as the point of departure.

FUNCTION BREAKDOWN

Five general functions were outlined in the Phase I study. These were:

(1) Prepare

(2) Brief

(3) Train

(4) Evaluate

(5) Debrief

As a result of detailed analysis of these functions during this phase, an expanded set was developed. The revised set includes:

(1) Prepare

(2) Brief

(3) Initialize

(4) Train

(5) Evaluate

(6) Debrief

(7) Manage Data

(8) Develop Syllabus

(9) Train IP

(10) Self/Peer Train

While some of the new functions were contained in the initial breakdown, several new functions were also developed which, while not inherently IP functions, interact with the IP console and therefore, must be considered. For example, "Self/Peer Training". These functions are presented in greater detail in the following paragraphs.

The functions are discussed as IP requirements and are partly based on current operations as identified in the Phase I effort. While it is useful to treat the functions as IP functions, it must be kept in mind that no permanent allocation to the IP is implicit. The functions, therefore, should be considered as instruction functions relevant to the training activities involving the Instructor Pilot, some of which may be allocated to machine (e.g., the simulation system) and some to man (e.g., the IP).

PREPARE. The preparation function encompasses all the efforts required to identify WHO? WHAT? WHEN? and HOW? In addition, it includes the requirements for analyzing the students' training needs and structuring the session to implement a "unique" syllabus. It can be subdivided into four major sub-functions:

(1) Identify Session

(2) Assemble Materials

(3) Review Data

(4) Develop Training Session

<u>Identify Session</u>. This sub-function identifies who and what is involved. It includes identifying the:

- Student
- Time of training session
- Simulator to be utilized

- Syllabus hop scheduled
- Simulator status

With the exception of information on the readiness or status of the simulators, the information is identical with that contained in the typical training schedule. Although the mechanics of presenting the information to the IP can be improved, the information required (except for simulator status) is currently provided. The simulator status information is essential to developing the implementation plan. The information needed includes status of both simulation and training sub-systems. As was pointed out in the Phase I report, except for major system failures, e.g., motion system inoperative, the IP receives little information on malfunctions or degredations which, although they may appear insignificant in simulation terms, may be catastrophic in training terms. This is particularly true in terms of cockpit displays and instructor displays.

Assemble Materials. The Phase I report pointed out that a major problem area involved the lack of training session support materials for use by the IP. Latest efforts of some of the ISD programs which have addressed the instructor pilot (e.g., SH-2 ISD) have recognized this problem. However, the total simulator syllabus information requirement must be addressed. The problem is compounded by the variety of simulator designs.

Among the information requirements involved are:

- Student file
- Syllabus hop description
- Scripts
- Scenarios
- Check lists/guides
- Initialization data
- Data recording sheets
- Grade sheets
- Simulation utilization data sheets
- Flight plans

The Phase I study highlighted the problems in this sub-function by pointing out the general lack of required information except for the student file (generally available at the training office) and the simulator utilization sheet (generally provided at the simulator). In general, although there were many exceptions, detailed simulator training syllabi, scripts, scenarios, check lists, performance data sheets, etc., are not available. However, early ISD models did not provide for explicit allocation of training objectives to simulators. Therefore, the deficiencies outlined above can be expected to continue in operational simulation training programs until the ISD models currently under development can be implemented into these programs.

Review Data. Unfortunately, much of the information required for review is not available as pointed out in the Phase I report. Student grade sheets for simulator training are not oriented to the synthetic situation and the potential for objective assessment. The syllabus is flight oriented and so does not provide the IP with detailed data on objectives and techniques to exploit the simulator's capacity to acheive these objectives. The syllabus should, for example, provide explicit delineation of:

(1) Training objectives

(2) Performance criteria

(3) Hierarchical priorities

(4) Implementation procedures including the use of demonstration, record - replay, freeze, parameter locks, reset, and reinitialize.

These data when reviewed in connection with student history and simulator status form the background for the training session development.

Develop Training Session. The most important sub-function in preparation involves the actual planning of the training session or hop and designing it to meet the needs of the student. The Phase I report concluded that the shortcomings in existing syllabi, support materials and IP training resulted in this sub-function being ineffectively conducted at best. The quality of the information assembled in the first three preparation sub-functions, i.e., identify, assemble and review, determines the quality of the output of this sub-function.

The development tasks include:

a. Individualize syllabus to students' needs.

b. Modify initial conditions as required.

c. Schedule and program malfunction/emergencies.

d. Structure controller functions

e. Develop tactical scenarios.

f. Format demonstrations.

g. Structure performance measurement requirements.

h. Structure display and control requirements.

i. Review contingencies, i.e.,

- crashes, missed procedures, unacceptable performance
- simulator emergencies, e.g., fire, loss of communication, hydraulic malfunctions

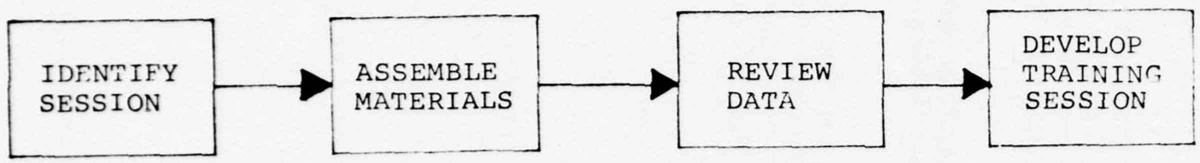
j. Outline briefing sessions (both student and training staff).

Summary. The Preparation Function was sub-divided into four sub-functions. All reflect activities in which the IP must prepare himself to conduct a simulator training session. The tasks involved are not trivial and the information requirements are extensive. The success of the training session is highly contingent on the thorough completion of preparation activities. As pointed out in the Phase I report, much of the required data does not currently exist or is not in a usable format. Figure 1 summarizes the Preparation Function.

BRIEF FUNCTION. Two important sub-functions are involved, namely briefing of the student and briefing of the training support staff who will be involved in the training session. The critical data to be included in the student's brief are:

- planned evolution
- learning objectives
- performance criteria

PREPARATION FUNCTION



Identify Session

- Student
- Time
- Simulator
- Syllabus hop
- Simulator Status

Assemble Materials

- Student file
- Syllabus hop data
- Scripts
- Scenarios
- Check lists/guides
- Initialization data
- Data recording sheets
- Grade sheets
- Utilization data
- Flight plans

Review Data

- Student history
- Syllabus hop
- Simulator status

Develop Training Session

- Individualize hop
- Modify initial conditions
- Schedule mal-functions
- Structure con-trollers
- Develop scenarios
- Format demonstra-tions
- Structure performance measures
- Structure display/control
- Review contingencies
- Outline briefing sessions

BASIC DATA/ACTIONS

Figure 1. Preparation Function Characteristics

- emergency procedures
- simulator discrepancies/characteristics
- planned use of training controls, i.e., Freeze, Reset, Replay, Demonstration, etc.
- communication procedures
- flight plan data

The briefing for the support staff will vary with the nature of training session and the staff. If additional instructor personnel are involved, the briefing must include explicit definitions of training responsibilities and interactions and the approach for achieving the required integration. In any case, the briefing must review the planned evolution and contingencies.

A more detailed review of the instructor interaction problem was completed and will be summarized under a separate subsection.

INITIALIZE FUNCTION. The initialization function involves all of the actions required to prepare the simulator for training which ends with the student(s) in the cockpit. The function logically subdivides into three sub-functions, i.e.:

(1) Configure Simulator

(2) Initialize Simulator

(3) Establish Readiness

The first is primarily concerned with mechanical aspects, i.e., positioning switches, breakers, controls, etc. The second is concerned with entering the initial conditions of the simulation into the system, and the last, with final overall readiness checks.

Configure Simulator. Three tasks are required to configure the simulator. They are:

(1) Configure simulation system

(2) Configure crew station

(3) Configure IP console

All are similar in being directed to creating a standard

system configuration as a point of departure. The first is directed to ensuring that the simulation system is ready and in a "stand-by" or "idle" mode of operation. It involves establishing that the correct program is loaded and the computer(s) is in the training mode; that the support systems such as motion, land mass and visual are functioning, "zeroed" and ready; and that the computer peripherals required for the session are in the proper mode and also ready.

The second task involves verifying or establishing the standard configuration of the crew station. The configuration for pilot training will normally reflect the post-landing checklist.

The third task is concerned with configuring the simulator consoles. Although it approaches the initialization function in activities, it can be separated in terms of objectives. As pointed out earlier, configuration (as opposed to initialization) of the console is concerned with establishing a common point of departure for the initialization activities. While they could be combined, the result would dictate that every display and control be incorporated in the initialization process, a process which is more concerned with establishing specific or unique conditions rather than a common set. Thus, data for the configuration check are typically contained in the simulator utilization manuals whereas the initialization data are contained in the syllabus. Included in the configuration tasks are clearing malfunctions and overides, setting displays and modes; in short checking each switch or control and display to achieve a standard pre-initialization console configuration.

Initialize Simulator. Three tasks are involved in initializing the simulator. All are concerned with modifying the standard configuration (achieved in the preceeding configure sub-function) to meet the specific requirements of the planned training mission. The size of the task varies with the computer program sophistication, weapon system complexity, air crew characteristics and support instructor/operator personnel.

The first task is concerned with entry of all initial conditions data. To the extent that all or portions of these data are already resident in the computer, the task is simplified. In any event, the data which may be entered include:

- aircraft configuration and stores
- aircraft location (including attitude, altitude, heading and speed, if airborne)

- environment(s) - ceilings, visibilities, temperatures, winds, magnetic variations, turbulence, and ocean characteristics

- radio/nav aids - location, characteristics, and degradation

- targets - locations, speeds, characteristics, and behavior

- malfunctions/emergencies

- airfield(s) - locations, characteristics, and facilities

- carrier(s) - types, locations, speeds, characteristics, sea state, and degradation

- display selections

- printout selection

- plot selection

The second initialization task is concerned with inserting pre-programmable events and their triggers. Where pre-programming is minimal, pre-selecting for simpler activation is possible and included. The typical data included in pre-programming are:

- variety of reset positions, e.g., in flight, carrier airfield(s) and their characteristics

- radio/nav aid facilities and characteristics

- malfunctions/emergencies

- demonstrations

- changes to performance recording/monitoring

- changes to environment(s) - weather, turbulence, and winds

- changes to targets and behavior degradation

- new targets, characteristics and behavior

These data are generated during the Development Sub-function of the Prepare Function and arise from the basic simulator syllabus, IP inputs, and training models (if available).

The third task is concerned with initialization of the crew station. This task varies with system and crew size. It involves making those changes to the standard crew station configuration (achieved in the configure Simulator Sub-function) required for the training mission. Three types of changes are generally required. The first are changes which impinge on the student pilot, e.g., placing switches, breakers, etc., in incorrect or degraded mode positions. These are part of the developed training syllabus. The second are those changes required to utilize the cockpit with other air crew personnel "missing" e.g., the NFO in the F-14, F-4, A-6 and the copilot in the S-3, P-3, SH-2 or SH-3. The "settings" are those required for pilot training with the IP simulating the missing crewmen. The third involves those changes in the cockpit controls required to align the cockpit and the initialization data. For example, when the initialization is an in-flight condition, the throttles must be advanced to match the power "simulation condition." Aircraft configuration controls, e.g., wheels, flaps, brakes, and wing switches and levers must be positioned to agree with initialization conditions. Unless this synchronization is achieved, the initialization data will be correspondingly altered to agree with the cockpit upon activating the simulator system. The results are generally catastrophic for training, i.e., the planned mission cannot be flown and often results in a "crash" because of an unflyable condition, e.g., stall because of gear and flaps out, swept wing and engines in idle at final approach fix.

Establish Readiness. The final sub-function in the initialization process involves the "GO - NO GO" checks for verification of readiness to start the training mission. The function is typically well performed in current simulator training operations. Although the details vary with characteristics of the system, they include verification that:

- student(s) are in the cockpit with required safety equipment in place
- area is secure and safe
- support material (scripts, scenarios, and data sheets) are available
- other instructor personnel are in position
- communications with the support staff and student have been established
- ramps/supports, etc., have been retracted
- initial conditions have been entered

In short, the task typically ends with the training system in the "Freeze" condition with:

- motion system erected
- visual system aligned and operating
- initial conditions set
- aircrew prepared to take control

Summary. The Initialize Function achieves a "tailoring" of the simulation system to meet the unique needs of the specific training mission to be executed. The first step places the simulator into a standard configuration in terms of both software and hardware. The second step modifies the standard configuration as required by the specified condition of the syllabus mission. The third task is a final verification that the system is ready for training. It includes checks for both safety and readiness.

TRAIN FUNCTION. The basic operation of the simulator occurs in the Train Function. Although the allocation of functions between instructor and simulation system vary significantly among existing operational trainers, four basic instruction sub-functions must be accomplished. They are:

(1) Control Simulator

(2) Monitor Performance

(3) Instruct

(4) Record

These sub-functions, unlike those in the previous functions which were performed sequentially, can be and are typically performed simultaneously and repeated as necessary.

Performance evaluation, because of its importance, has been identified as a separate function even though much of the activity occurs simultaneously with the Train Function.

Control Simulator. The control sub-function has been divided into nine tasks. Two tasks are trivial (or should be) in that they involve activating and deactivating the simulation system; one is a simulation task, five are training control tasks and one is a monitor task. They are:

- activate simulation systems

- provide interacting manned system simulations
- activate-deactivate emergencies/malfunctions
- select and activate demonstrations
- set and select replay
- freeze
- initialize and reset
- monitor safety
- deactivate trainer at end of session

The activate and deactivate tasks are straight forward, providing the training mission has been well planned.

The supporting simulations of interacting manned systems can and typically do involve a sizeable task. The Phase I report summarized this task in a flow chart which is reproduced as Figure 2, and illustrates the magnitude of the problem. The information required for this task is contained in the scripts and scenarios developed earlier. The performance requirements can impose severe problems if the student is expected to "hear" different human controllers, aircrew and instructors and if targets are expected to respond intelligently and interactively.

The basic training control function for emergencies/malfunctions, demonstrate, replay, reset and freeze are simple in terms of activation, but complex in terms of decision requirements. The information required is found in two other functions, i.e., the detailed syllabus developed in the Prepare Function and the conclusions reached in the Evaluate Function.

The monitor safety function involves ensuring that other personnel do not enter hazardous areas such as the motion platform area, and that general safety items such as fire and mechanical failures are monitored.

The Control Simulator sub-function, thus, includes a set of activities concerned primarily with actual training control of the simulator and the control/simulation of interacting manned systems.

Monitor Performance. The Monitor Performance sub-function while directed primarily to student performance is also concerned with simulation system performance. The task involves measuring performance and is important to other Train Sub-

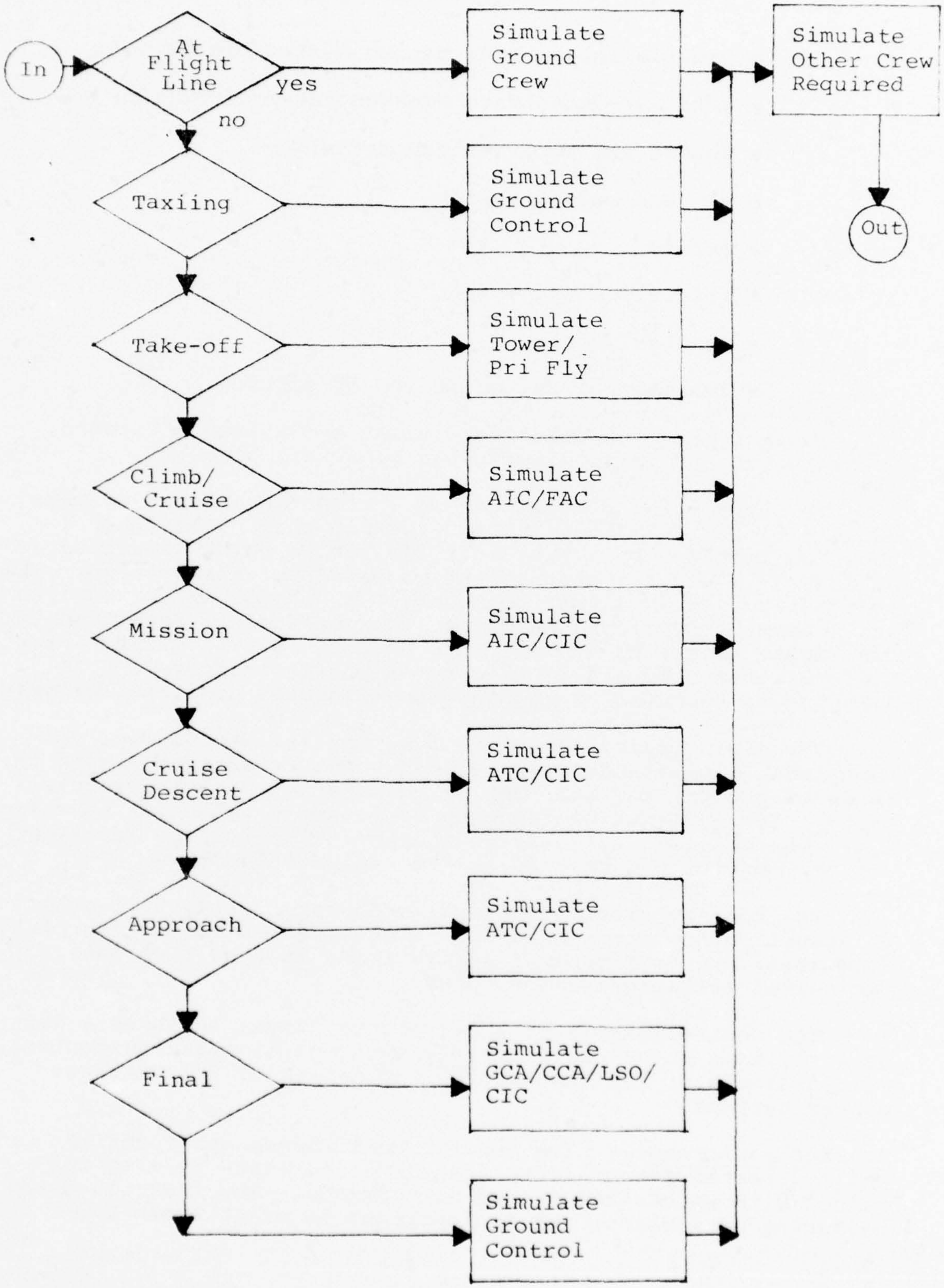


Figure 2. Simulation support function

functions (e.g., Instruct and Record) and to the Evaluate Function. The specific monitoring or measurement strategy should have been identified during the Prepare Function.

Four separate tasks are involved.

(1) monitor student procedures

(2) monitor student control technique

(3) monitor skill level

(4) monitor simulation system performance

Student performance can be structured under a variety of hierarchies or taxonomies. The procedures, control, and skill breakdown is one which has proven useful in simulator training performance measurement studies.[2] It groups data into categories useful for evaluation and debriefing since it divides performance on the basis of:

(1) Does the student know what to do? (Procedures)

(2) Does he know how to do it? (Technique)

(3) Has he reached the required performance level? (Skill)

Regardless of the scheme employed, relevant data must be sampled during the session to permit evaluation of the students' performance. This sub-function is concerned with sampling (and processing) of those data. What and when to sample was identified during the Preparation Function.

Simulator performance monitoring is required to detect simulator degradation which might affect training or necessitate contingency training plans. Loss of motion, visual or cockpit displays for example, could have a serious impact on a weapon system training mission.

Instruct. The instruct sub-function involves a wide set of training tasksor techniques which are grouped under four tasks. Again, a wide variety of alternative groupings are possible.

[2] Charles, John P. and Johnson, Robert M. "Automated Weapon System Trainer: Expanded Module for Basic Instrument Flight Maneuvers." Technical Report 74-C-0141-1, Naval Training Equipment Center, Orlando, FL (in printing).

Those outlined are:

(1) provide feedback data

(2) critique

(3) correct procedures

(4) provide technique data

In short, they are concerned with providing the student information on:

(1) How well he is doing.

(2) What he is doing wrong.

(3) How it should be done.

(4) Alternative or better techniques (especially for tactics).

Data inputs include the detailed syllabus, performance criteria, and performance monitoring data as well as data from the Evaluation Function. The output is explicit.

Record. The record sub-function includes both short term storage (training session) and long term storage (student/officer personnel jacket). The data to be recorded can be clustered under four categories.

(1) data for feedback

(2) data for simulator training control

(3) data for debrief

(4) data for records

The data to be recorded were identified in the developed detailed syllabus, sampled and processed in the performance monitor sub-function, and then sorted and output according to the needs identified above.

Summary. The Train Function is concerned with the actual operation of the simulation system. It includes those sub-functions concerned with controlling the simulators, monitoring or measuring student performance and simulator performance, basic instructing tasks and output or recording of results. The sub-functions are interactive and non-sequential. They are completed when the student achieves criterion performance

or the training period is over. In general, the information requirements are provided by other sub-functions. The characteristic of the function is best described as the implementation of the detailed training mission plan.

EVALUATE FUNCTION. Performance evaluation is differentiated from the Train Function both because of its importance and because of the basic differences between control/data processing (Train Function) and data analysis/evaluation which is the objective of the Evaluate Function. Six related sub-functions were identified. They are:

(1) monitor relevant parameters for each mission segment/phase/leg

(2) establish relation of performance to expected/required performance envelope

if, (3) below criteria, diagnose problem

(4) select instruction technique to apply

(5) revise training plan as required to implement

(6) brief student and support staff as required and proceed

The Evaluate Function is, at least for the near future, a classic decision function in that a course of action must be selected in the face of some uncertainty as to the optimum solution. As such it is heavily dependent on the characteristics of the data and their processing. The output is a syllabus adapted in near real time to the performance and training needs of the student.

The information requirements include the detailed learning objectives, and performance requirements identified in the Prepare Function, the performance monitor data developed in the Train Function. Diagnostic models or diagnostic capabilities which can relate the results to the dynamic learning process and forecast or predict sufficiently to permit restructuring the training mission are required.

DEBRIEF FUNCTION. The Debrief Function is the last sequential function of the basic simulator training session, i.e.;

Prepare
↓

Brief

↓

Initialize

↓

Train

↓

Evaluate

↓

Debrief

Two tasks are involved, i.e., debriefing of the student and debriefing of the simulator support crew.

Debrief Student. The student debriefing can be divided into six tasks.

(1) organize data for debriefing

(2) assemble debriefing materials

(3) review problems with student

(4) review learning objectives with student

(5) review training status with student

(6) outline recommended actions with student

The first two tasks are preparation for the debriefing and involve prioritizing or structuring the debrief and assembling materials such as printouts, plots, plans and notes. The last four tasks encompass the actual debrief and are aimed at clarifying for the student what he was expected to do, what he did wrong, what his progress was and any recommendations to help the student.

The Debrief Function is similar to the Evaluate Function in being diagnostic and decision oriented.

Debrief Simulator Crew. The second part of the debrief function involves debriefing the support crew, both other instructors and the operators. The objective is to review the training evolution and management problems which arose as well as functions and tasks which were well done. In addition, the debrief function is utilized to summarize simulator discrepancies and operating problems.

MANAGE DATA FUNCTION. Three sets of data are associated with simulator utilization in pilot training. These are:

- Student Data
- Simulation System Data
- Training Data

The development and management of these data although not entirely IP functions are logically part of the instruction process and should be addressed as part of the problem.

Student Data. Information on student performance is required for two different purposes. Although a single data file could meet these demands, current and near future training system designs indicate that end users may not have access to a common data bank. The two requirements are for:

a. student files/jackets

b. simulator training files

The student's jacket requires data compatible with performance from other training media including in-flight. The data must follow a format which is meaningful and compatible with other scoring/grading systems.

Simulator training files contain the detailed performance data which can be developed uniquely in the simulator and can be used to diagnose and adapt the simulator syllabus to the student's needs.

Simulation System Data. Two types of data on the simulation system are required. They are:

a. simulator utilization data

b. discrepancy data

The utilization data is normally prepared by the Simulator Operator (SO) for resources management. The discrepancy data establish the readiness of the trainer for the next training session and maintenance/repair requirements. The IP input is particulary important to identify training function discrepancies.

Training Data. Data are required to permit the evaluation of simulator training and includes identification of student, instructor, specific syllabus and results.

DEVELOP SYLLABUS FUNCTION. The digital computer can provide the capability of storing syllabi for recall when needed. It can also provide the capability to modify and update the syllabus data which was stored. This requirement consists of four sequential tasks:

(1) Identify the changes

(2) Format the changes

(3) Implement the changes

(4) Validate the changes

The IP must be intimately involved in the first and last tasks. With an interactive terminal and user language, he can readily perform all four. In fact, tasks 2 and 3 become trivial if modern computer technology is utilized.

The changes are of two types. One is concerned with changes required to align the syllabus with the system and tactical changes. The second is concerned with improving the training effectiveness of the syllabus. The latter draws heavily on the data processed in the Manage Data Function.

TRAIN IP FUNCTION. The Phase I study concluded that the most critical problems in the utilization of the Instructor Pilot in simulator training were:

a. The lack of training in how to effectively utilize the simulator.

b. The lack of standardization in syllabus implementation.

While other factors such as poorly composed syllabi and lack of training on "How to Instruct" contribute to the problem, the simulator utilization training must be provided if the simulator is to be an effective media. The simulator itself provides the basic tool for this training. The subfunctions to be provided include:

a. Simulation Operation

b. Simulator Training

c. Simulator Syllabus Development

d. Standardization Training

Simulator Operation. The first sub-function includes the tasks required to teach the IP the basic operation of the simulation system or that portion of the device which he will utilize. The training includes:

- console familiarization
- console operation
- operating procedures
- syllabus implementation

Simulator Training. The second phase of the IP training is concerned with unique simulator training capabilities and problems. The task addresses the differences between flight and simulation training capabilities and how to utilize the simulator's training functions. Four tasks were identified. They are aimed at providing the IP training in:

- training function usage
- training techniques
- evaluation
- simulator instructing

Training function usage refers to the unique training controls available on modern simulators. These include features such as:

- initialization to any point in the system's performance envelope
- record and replay of student's flight
- demonstration of good or bad performance with the student in the cockpit
- reset and reinitialize to any point in the envelope
- freeze and fly out/reset and fly out

The objective is to teach how and when to utilize these features effectively.

Training techniques refer to the use of selected training approaches using a simulator. It should include training in the importance of specifying training objectives, performance

criteria, feedback, part task training, and adaptive training.

Training in evaluation of student performance is particularly important for the IP (who is also a Flight Instructor) for two major reasons. First, the simulator system can provide the IP with a wealth of data on student performance ranging, for example, from time plots to statistical analyses of tactical errors. Second, the simulator is not an airplane, and regardless of the realism achieved, the student's performance must be placed in this perspective.

Simulator instructing provides "hands-on" training. A "simulated student" and an instructor training syllabus are required. The Instructor Pilot instructor functions are identical to the training functions described in the previous pages.

Simulator Syllabus Development. Training in how to develop and implement a simulator training syllabus concludes the IP training function. Aside from the mechanics of using an interactive terminal, the requirement and procedures for syllabus configuration control are included.

Standardization Training. This sub-function provides instructor standardization checks in simulator training. The function requires checks of both IP syllabus implementation and student pilot evaluation. The simulation system can be utilized for this function.

SELF/PEER TRAIN FUNCTION. The use of the simulation system by students without an IP at the console can increase utilization of the device and decrease instructor requirements. It is included as an instructor function since several "instructor" capabilities must be incorporated in the instructor console to permit this mode of operation. This is particularly true if training effectiveness is to be achieved. In fact, a limited automated instructor function must be implemented. The sub-functions required are:

a. Basic Simulator IP Functions

b. Syllabus Lockouts

c. Performance Lockouts

In addition critical simulator controls must be provided in the cockpit. These include the function of Start/Run, Freeze, Reset, Training Mission Selection, Demo Selection, Record Replay and Emergency controls.

Basic Simulator IP Functions. The sequential training functions

presented in the preceeding pages are required. However, they can and should be minimized to the practice objectives of the Self/Peer Training Function. The sequential training functions include:

a. Prepare

b. Brief

c. Initialize

d. Train

e. Evaluate

f. Debrief

In addition, the Student Data and Simulator Data sub-functions of the Data Management Function are required.

Syllabus Lockouts. Although data indicates the technical feasibility of implementing Self/Peer training in a practice mode, *it is not clear, for example, that new skills acquisition can be accomplished.* Therefore, a syllabus lockout should be incorporated to preclude the student "getting ahead" of the IP controlled syllabus or attempting maneuvers or missions before he has acquired the prerequisite skills under IP guidance.

A second type of lockout is also required to ensure that the syllabus lockout cannot be bypassed. This requires a student file lockout to prevent the student from altering his training record or from accessing other records with instructor data.

Performance Lockouts. To ensure that Self/Peer training does not result in the acquisition of undesirable performance, a "performance" lockout sub-function should be implemented. This requires that the system monitor the students' performance and stop training when errors are repeated and the diagnostic system cannot solve the problem when acquisition degrades below some value. A similar lockout for the opposite reasons, i.e., achievement of beyond criterion performance is required to preclude "learning to fly the simulator" as opposed to learning to fly the weapon system and to permit efficient use of the training resources.

SUMMARY. Ten functions have been analyzed to provide the IP functions in simulator training. No allocation of functions (to IP or simulator system) are implied in this analysis except for the Self/Peer Training Function which requires at least a partial automation of the IP functions. Appendix A contains a

detailed list of the functions and related requirements.

FUNCTION ALLOCATION

Trial allocations of the IP functions were made. Because of the wide variety of the current generation of trainers and of the roles of the IP as a function of different systems (see Phase I report) only a generic allocation was finalized. While the result is conceptually feasible, demonstrations of technical feasibility are required for some allocations. In addition, field trials of the acceptability of the revised role of the IP and the training implied need to be undertaken.

Several assumptions are inherent in the allocation and reflect the results of the Phase I effort.

Assumption I. The simulator IP will also be a flight IP, i.e., he will not specialize in simulator training.

Assumption II. The allocation must reflect at least the constraints imposed by existing technology and that which might be available in the near future (5 years).

Assumption III. A mix of training media including flight will be utilized in pilot training.

The first assumption generates a practical design constraint in that the skills developed by the IP for flight instructing should also be used in simulator instructing. At the minimum, they must not conflict or transfer negatively. Thus, the IP's ability to evaluate student performance in flight and structure remedial exercise should be exploited in the simulator. The implication is that the information utilized for inflight evaluation, for example, should be presented similarly in the simulator to capitalize on that skill.

The second assumption contains the level of automation to be considered.

The third assumption permits the simulation training system utilization to be optimized. Knowledge and skills more efficiently taught with other media can be designated as prerequisites for simulator training. The syllabus implications are obvious.

An assumption which does not need formalizing is concerned with the efficient use of personnel. It was assumed that if an IP is required for any reason, then the allocation should proceed to utilize the IP "full time" by allocating

him additional functions based on automation costs and IP training costs.

Within these limited constraints the allocations outlined in Table I were developed.

TABLE 1. ALLOCATION OF TRAINING SUBFUNCTIONS

Function/Subfunction	Allocation: Instructor	Allocation: Simulator System
1. Prepare Function		
1.1 Identify Session		X
1.2 Assemble Materials	Supports	X
1.3 Review Data	X	
1.4 Develop Training Session	X	Supports
2. Brief Function		
2.1 Brief Student	X	Supports
2.2 Brief Simulator Crew	X	
3. Initialize Function		
3.1 Configure Simulator	X	
3.2 Initialize Simulator	X	Supports
3.3 Establish Readiness	X	
4. Train Function		
4.1 Control Simulator	Supports	X
4.2 Monitor Performance	Supports	X
4.3 Instruct	X	Supports
4.4 Record	Supports	X
5. Evaluate Function		
5.1 Monitor Parameters	Supports	X
5.2 Performance in Limits (?)	Supports	X
5.3 Diagnose Problem	X	Supports
5.4 Select Remedial Technique	X	Supports
5.5 Implement	X	Supports
5.6 Brief Crew	X	
6. Debrief Function		
6.1 Debrief Student	X	Supports
6.2 Debrief Simulator Crew	X	
7. Manage Data Function		
7.1 Student Data	Supports	X
7.2 Simulation Data System	Supports	X
7.3 Training Data	X	

TABLE 1. ALLOCATION OF TRAINING SUBFUNCTIONS (cont.)

Function/Subfunction	Allocation: Instructor	Allocation: Simulator System
8. Develop Syllabus Function		
8.1 Identify Changes	X	
8.2 Format Changes	X	Supports
8.3 Implement Changes	X	Supports
8.4 Validate Changes	X	Supports
9. Train IP Function		
9.1 Simulator Operation	Supports	X
9.2 Simulator Training	Supports	X
9.3 Simulator Syllabus Development		X
9.4 Standardization Training	Supports	X
10. Self/Peer Train Function		
10.1 Basic Simulator IP Function		X
10.2 Syllabus Lockouts		X
10.3 Performance Lockouts		X

Of the 35 subfunctions involved, 16 have been assigned primarily to the simulator system and 19 to the instructor (IP or Instructor Pilot Instructor). The system supports the instructor in 11 functions and the instructor supports the system in 11 functions. Therefore, the interaction between man and machine is extensive. Most of the support functions of the instructors are "by exception" type, i.e., he can accept or alter the plan or decision developed by the system.

The system functions reflect the following technology levels:

- existing advanced mini-micro computers
- existing advanced displays
- existing programming technology
- feasible modeling and software implementation
- advanced computer peripherals such as speech generation and understanding

It is clear that the "simulator system" to which functions were allocated does not resemble existing simulators. A new set of requirements has been imposed. Some of the functions may appear similar. They are significantly different from

simulation requirements - they are training requirements. However, they can be implemented through the capabilities provided by digital computer technology. The implications for design are outlined in the following discussion of modular concepts.

The function allocation significantly reduces the role of the instructor in simulator control during the training session. To the extent that it reaches this goal, it increases his load in terms of instructing functions, i.e., observing the student, evaluating performance, and structuring remedial training activities.

In summary, the generic function allocation developed results in a highly interactive console in which maximum support is provided the IP. He is freed of routine control functions and data is provided or "callable" for decision functions. The resultant role emphasizes the unique (at least for the near future) capability of the IP to identify performance problems and help the student solve the problem. This capability is particularly important at weapon system levels (including tactics) whose decision models, even if conceptually feasible, could not be implemented at the training level because of cost and complexity.

NAVY FLIGHT OFFICER INSTRUCTOR (NFOI) INTERACTION

The Phase I study after summarizing the role of the IP recommended that the IP/NFOI interaction be investigated. This interaction was viewed as important in simulator training for Multi-place Fighter, Attack and ASW systems.

Furthermore, the problem appeared to exist primarily in those systems where the pilot(s) interacted with the weapon system (e.g., the F-14) as opposed to those in which the pilot(s) tasks were almost exclusively flight tasks (e.g., the E-2). The physical location of the IP relative to the NFOI obviously compounds the problem.

A review of the A-6, F-14, F-4, P-3, S-3, E-2 and SH-2 syllabi, simulators and readiness training operations was conducted. The distinction between systems in which the pilot(s) primarily fly the vehicle as opposed to weapon systems operation clearly separated these systems into two sets. The P-3, S-3, and E-2 typify the set where the pilot(s) tasks are almost solely flight tasks. The F-4, F-14, A-6 and SH-2 typify the set in which the pilot has both flight systems and weapon systems tasks. The interaction problems will be reviewed under the two headings "Flight Systems Only" and "Flight and Weapons System Tasks."

FLIGHT SYSTEMS ONLY. The training syllabi for this type of system reflects the separate tasks of the pilot(s) and crew. Pilot training is typically conducted separately until the crew and pilots meet for flight training. The simulators follow this pattern with pilot trainer cockpits generally located on their own motion platform and typically operated in the OFT (operational flight training) mode. The IP typically rides the platform seated at a console from which he can control the flight training syllabus. The weapons or tactics trainer under NFOI control is either physically (or virtually) a separate training system and evolution.

For these systems it appears that the only requirement for a full system operation (if possible) is for the NATOPS checks. An integration problem can exist. For example, communication between NFOI and IP is even a problem in some existing devices. However, the integration requirement is minimal, and IP/NFOI interaction is limited.

Another type of interaction can exist and will exist in future trainers for this type of system. The weapons/tactics simulation may require flight control inputs to the simulation. A pilot (sometimes an IP) may be required to provide these inputs at the instructors console, especially in advanced training where realistic flight conditions need to be created. However, no problem is forseen in these operations, since it is clear that the NFOI is the instructor in charge and the IP or other qualified pilot(s) are contributing to the simulation, not instructing.

<u>Summary</u>. The IP-NFOI interaction problem in simulator training systems for weapon systems in which the pilot(s) functions are primarily flight control tasks is minimal. The NFOI and IP effectively teach independently. Where integrated training does occur, it is of a highly specialized type such as a NATOPS check. The detailed specification for these training missions should preclude any interaction problem, especially with adequate briefings and agreements on the course of the evolution.

FLIGHT AND WEAPONS SYSTEM TASKS. The typical training syllabi for Weapon Systems in which crew (NFOs and pilots) integration is essential to mission performance can be divided into two phases. The first can be described as familiarization and subsystem qualification. During this phase the pilot and NFO are trained separately, the pilot in flight tasks, the NFO in weapons and tactics. Simulator support is provided to both. The simulation may be physically independent, e.g., 2F95 and 15C9 for the F-14 or the same

trainer used alternately by the NFOI and IP, e.g., the 2F88 for the F-4. For this phase of training, little interaction occurs between the NFOI and IP at the console - each instructor uses a separate syllabus.

The second phase of training brings the pilots and NFOs together for training as a team in weapon system operation. The simulation system(s) must be integrated for this type of training. The basic problem is simplified if the simulation system is capable of operating in either mode, i.e., independent (tactics and flight) or integrated system. The problem is technically more complex where two separate trainers must be integrated (e.g., 2F95 and 15C9). However, simulation integration is only part of the problem since the NFOI and IP must also be integrated and interact.

NFOI-IP Interaction. Although the solution to the NFOI-IP interaction problem may change for future systems, it became clear during the review that the NFOI assumes the role of controlling instructor for integrated weapon system training. Exceptions were observed based on individual experience and qualifications. Two factors appeared to establish this modus operandi; one reflects the basic functions of the NFO and the IP in the system and the second reflects simulator design for these systems.

The NFO in the typical pilot/NFO team contributes the target(s) acquisition and engagement solution, including threat evaluation and countermeasures. The pilot's dominant role generally occurs in the final attack phase. Thus, problem generation and development logically become NFOI tasks.

The NFOI console, since it is used for NFO basic training in systems and tactics in the independent mode, contains the basic displays and controls for problem generation and control. It is logical and economical to utilize this console for similar functions in the integrated mode.

Thus, both because of the nature of the role of the NFO in weapon systems and the design of the NFOI console in weapon system simulators, the NFOI typically assumes the role of controlling instructor in integrated training. IP functions remain essentially the same as in basic phases of pilot readiness training.

Summary. Interaction between the IP and the NFOI occurs primarily in systems in which the pilot(s) and NFO(s) function as a team in the system. Any interaction problems in simulation should occur only in advanced readiness training when

they are brought together for training as a team. In this phase, the NFOI will probably be the controlling instructor. Some existing simulator designs do not address IP/NFOI interaction in the integrated mode.

MODULAR CONCEPTS

Alternative implementation concepts were developed and studied. In addition, the feasibility of modifications to current generation trainers was considered in terms of accommodating the functions developed. It became clear that the ten primary IP functions which had been developed imposed different types of requirements on the simulation system. Some functions require the simulation program - others do not. However some of the latter can, and should be, performed concurrently with the simulation. These can be accommodated in a background mode of the real-time simulation. Those functions not requiring the simulation program are identified as "off-line" requirements. Therefore, the first step taken was to separate the functions on the basis of these simulator program requirements. Figure 3 presents these results. The Instructor Training function requires both the Foreground and the Background modes and will be discussed separately.

"Real-Time" Requirements		"Off-Line" Requirements
Foreground Mode	Background Mode	
Initialize	Brief	Prepare
Train	Debrief	Manage Data
Evaluate		Develop Syllabus
Train IP		
Self/Peer Train		

Figure 3. IP computer system requirements

The functions associated with the background mode under the "real-time" requirements as well as those listed under the "off-line" requirements suggest the feasibility of utilizing remote terminals for the implementation. Therefore, the functions were analyzed in terms of training evolution occurrence. Figure 4 summarizes the results. A typical one hour training mission was assumed. Fifteen minutes was allotted for the initialization function. This is a conservative estimate of the time required. The figure indicates that the terminal will be available for other background and off-line functions, such as Manage Data, Develop Syllabus and Computer Assisted IP Training. Although all Syllabus Development in existing simulators is done "off-line", remote terminals with well designed supporting software should permit this function to be performed with the simulator

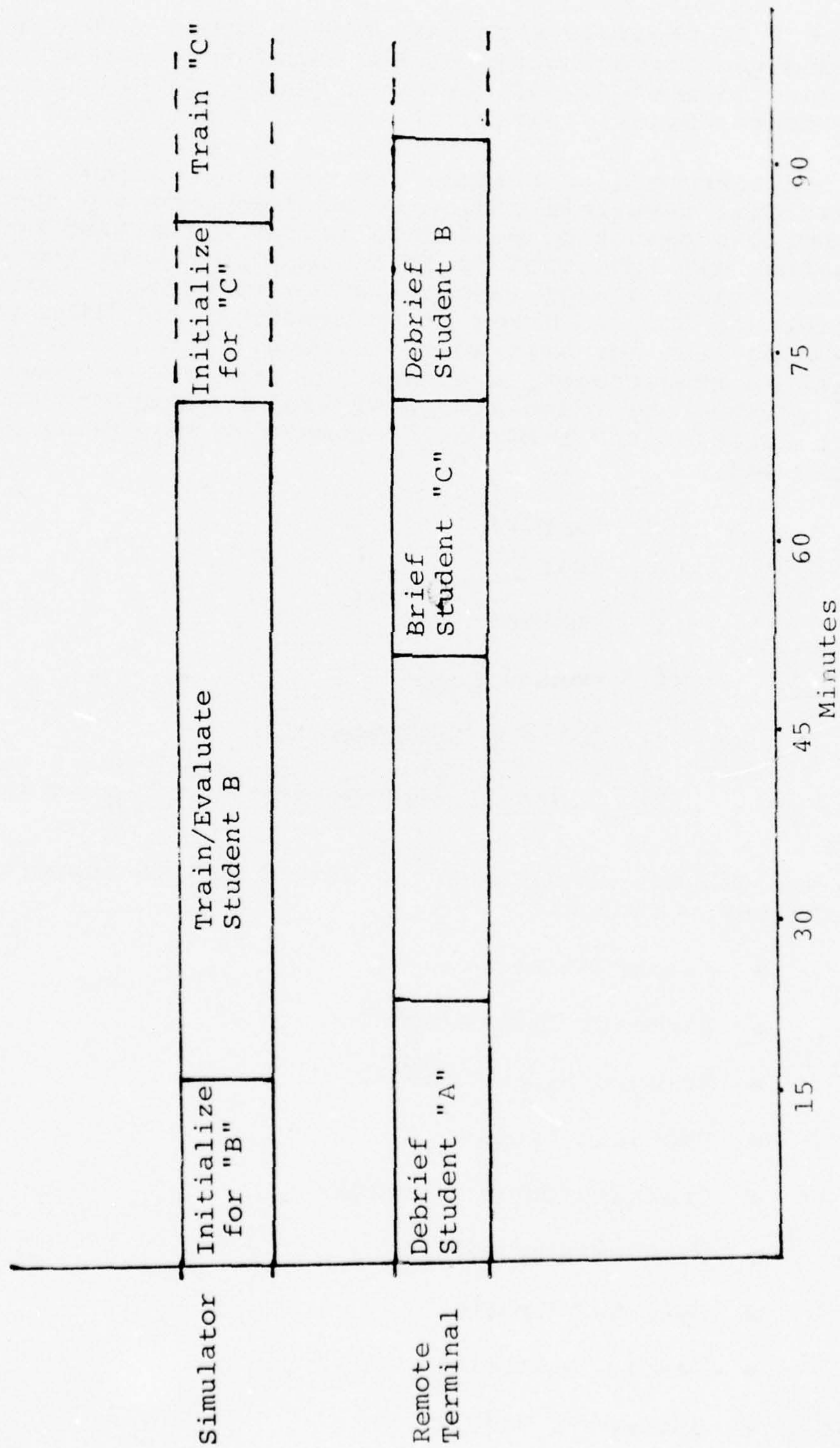


Figure 4. Overlapping use of remote terminal and simulator

operating. If separate terminals can be used to meet the background supported functions, the simulator system could be designed to meet six of the seven basic training functions, i.e., Prepare, Brief, Initialize, Train, Evaluate and Debrief.

Since there does not appear to be any technical reason why additional terminals could not be added and why the off-line functions cannot be performed in the background mode, it appears that all functions could be performed with the simulator in a training mode (except for maintenance). This is desirable, not only in terms of utilization, but also in terms of providing time for self/peer training. Thus, depending on the detailed requirement, a simulation training system could consist of the basic simulator with student stations and instructor consoles and a number of remote terminals to meet the functions of:

(1) Prepare

(2) Brief

(3) Debrief

(4) Manage Data

(5) Develop Syllabus

(6) Train IP (not requiring the simulation system)

A set of nine modules can be structured to support the ten functions. They are:

- Flight Module
- Aircraft System Module
- Weapons System Module
- Tactical Module
- Training Control Module
- Performance Module
- Syllabus Module
- Remote Module(s)
- Student's Module

The Flight, Aircraft System, Weapons and Tactical modules provide information display. Only the flight module need reflect cockpit displays. The rest should provide only the required information in readily assimilated format. The displays are system sensitive and thus may change with system modification or alteration.

The remaining modules provide both controls and displays. The modules could be designed to a "standard" configuration, especially in operations.

- Flight Module - provides IP the equivalent of cockpit displays for monitoring student performance. This module is designed to capitalize on the IP's flight instructing skills and should duplicate cockpit displays essential to evaluating aircraft and student conditions and performance.

- Aircraft System Module - like the flight module, this module should provide the IP data on status of aircraft systems. It should not and need not duplicate cockpit displays since it does not serve a controlling function.

- Weapons System Module - provides information on status of weapon system, but only information relevant to training functions.

- Tactical Module - provides display of tactical situation including plots and target control data.

- Training Control Module - all training controls and required displays are located in the training module. It is the implementation of the Train Function.

- Performance Module - all student performance data is displayed at this module. Basic control of performance data processing should be provided.

- Syllabus Module - provides display of planned syllabus, control of the evolution and provides for input of the planned syllabus and changes to initialization data.

- Remote Module(s) - provides displays and controls required for Preparation, Brief, Debrief, Manage Data and Develop Syllabus. In addition, it provides a terminal for computer assisted IP training.

- Student Module - provides the student the required displays and controls for the self/peer training function. It

is located in the cockpit.

The modules and functions supported are summarized in Table 2.

TABLE 2. MODULE AND FUNCTIONS SUPPORTED

Module	Functions
Flight	Train; Evaluate; IP Train
A/C System	Train; Evaluate; IP Train
Weapon System	Train; Evaluate; IP Train
Tactical	Train; Evaluate; IP Train
Training Control	Initialize; Train;IP Train
Performance	Evaluate
Syllabus	Train
Remote	Prepare; Brief; Debrief; Manage Data
Student	Self/Peer Train; Train

In summary, a set of ten modules could conceptually meet the IP console requirements. Six are training implementation oriented and four are weapon system information display oriented. Although some of the display modules may resemble existing instructors console panels, it must be stressed that the modules are instruct<u>ion</u> oriented, not simulation control oriented.

SECTION V

DISCUSSION

No mention of the Simulator Operator (SO) was made in the analysis of the IP functions. Yet, it is clear that at least some tasks within the functions can be and perhaps should be accomplished by the SO. For example, he could assist the IP extensively during the Prepare Function in assembling materials and during the Initialize Function in configuring the simulator and instructor consoles and checking for readiness. However, it became clear that allocation of functions between the IP and SO would require specific and detailed simulator configuration and capability data. Thus, the general roles outlined in the Phase I report must form the point of departure for future weapon system simulator design. In addition, the specific allocation of functions should follow other guidelines developed in this study, e.g., if some functions are allocated to the SO, then sufficient and compatible additional functions should be allocated to create a "full-time" and meaningful job.

The functions and sub-functions developed to meet the simulator instruction objectives can be organized in many ways and some of the resultant modules for implementation might differ. However, the constraint of considering current generation and the next generation trainers renders the organization developed a practical one. It obviously reflects the hardware and software configuration of contemporary designs.

This can be summarized briefly as an approach which has exploited modern digital technology to mechanize simulation. The objective was realism. It and training effectiveness are not inherently synonymous. The resultant interface presented to the IP reflects control of simulation parameters not training. Therefore, the implementation of the functions outlined in the study must reflect this design philosophy. The advanced modules, for example, must "talk" to sophisticated weapon system simulators and exploit them for training purposes. On the other side of the interface is the IP with his unique flight experience, but untrained in simulation and at best "short coursed" in training technology. His requirements for support are extensive.

The function breakdown also generates new requirements. For example, the Prepare Function includes assembling materials such as syllabus mission description, scripts, scenarios, check lists, and data sheets. Yet, as reported in the Phase I report, these materials have generally not been developed within the typical training squadron.

The remote console as an adjunct to the simulator can clearly enhance the utilization of the device. Furthermore, if

properly implemented it can provide the support required by the IP in syllabus development. The brief/debrief support capability can fulfill a long standing need as pointed out in the Phase I report.

The student module, aside from permitting student use of the simulator, opens the possibility of using the display capability for feedback purposes.

The Manage Data Function needs to be explored further in terms of other data processing systems available to the training squadron. For example, the Versatile Training System (VTS) will soon be functional at most readiness training bases. The objectives and capability of the system in training information need to be considered in the design of the Data Management Module. At the minimum, the results of simulation training might be required by VTS for training jacket control. Similarly a VTS terminal at the simulator might solve the student history data requirement.

SECTION VI

CONCLUSIONS

The functions of the IP in simulation pilot training can be logically structured and allocated to manual and machine supported functions within the constraints imposed by existing simulator design philosophy. Implementation of the functions requires the use of interactive terminals operating in the background mode of the simulation software or operating as an independent system which "talks" to the simulator in terms of data exchange and control functions. The details of the implementation require weapon system data, at least as to the type of system involved, i.e., Single-Place attack or Multi-Place ASW.

The NFOI will be lead instructor during simulation training involving NFOs and pilots by virtue of the design of simulators and the role of the NFO in the weapon system.

The implementation of the functions outlined requires the development of supporting data. These include:

- detailed syllabi designed to simulator training requirements.
- detailed scenarios and scripts including controller messages and contingency options.
- learning objectives and performance criteria.
- check lists for configuration control and management.

Functionally standardized modules can be developed within the state-of-the-art to implement the functions of the IP. These modules can support IP training as well as "Self/Peer" training and related simulator training resources management data. The interface with other training data systems should be explored.

The relation of simulation training to other training media in implementing training objectives needs to be explored. Efficient and effective use of simulation requires the support of other training media.

Instructor console design should be function oriented, i.e., training oriented, as opposed to simulation control oriented. Achieving this type of interface between the IP and the simulation system is within the state-of-the-art providing requirements are well defined.

SECTION VII

RECOMMENDATIONS

The second phase of the study of the Instructor Pilot's Role in Simulation Training has generated generic data reflecting existing (and near future) simulator design data and readiness squadron implementation philosophy and capability. Achievement of optimum use of simulation training capability must depart from this operational context and within existing and near term technology, implement the functional requirements identified in this study. To achieve this goal, the following recommendations are advanced.

- A demonstration of the technical feasibility of implementing certain IP functions is required. These functions include:

(1) Computer supported Prepare Function. In particular, the feasibility of storing and providing (for acceptance) the basic training materials, including detailed implementation data, data requirements, contingency plans and suggested training curricula and training session objectives.

(2) Student briefing using an interactive computer terminal.

(3) Generation and presentation of feedback data via visual (cockpit displays), auditory (intercom) and hard copy techniques.

- An evaluation of Self/Peer Training effectiveness within the constraints identified, i.e., syllabus and performance lockouts. The benefits of peer training data systems such as VTS needs to be explored.

- The feasibility of conducting IP standardization training utilizing "simulated" students needs to be established and validated.

In general, the application of advanced highly interactive computer terminals to support simulation training should be explored. These investigations should concentrate on training or instruction requirements instead of simulation requirements.

The ISD methodology needs to develop techniques for allocating training objectives to the simulation training media. None appear to exist.

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APPENDIX A

IP FUNCTION BREAKDOWN

I PREPARE FUNCTION

1.1 Identify Session

- student
- time
- simulator
- syllabus hop
- simulator status

1.2 Assemble Materials

- student file
- syllabus hop description
- scripts
- scenarios
- check lists/guides
- initalization data
- data recording sheets
- grade sheets
- simulator utilization sheets
- flight plans, etc.

1.3 Review Data

- student history - performance problems/weakness
  - missing training elements
- syllabus hop - objectives
  - performance criteria
  - priorities
  - implementation procedures
- simulator status

1.4 Develop Training Session

- individualize syllabus to students' needs
- modify initial conditions as required
- schedule and program malfunctions/emergencies
- structure controller functions
- develop tactical scenarios
- format demonstrations
- structure performance measurement
- structure display and control
- contingency plans
  - performance failures
    - crash
    - missed procedures
    - unacceptable accuracy/quality
  - simulator reset strategy
  - simulator emergency
    - fire
    - hydraulic malfunctions

- loss of communications
- area safety

- outline briefing sessions
  - student(s) - objectives
    - criteria
    - procedures/approach
    - simulator problems
  - simulator staff - responsibilities
    - evolution strategy

II BRIEF FUNCTION

2.1 Brief Student(s)

- planned evolution
- learning objectives
- performance criteria
- simulator emergency procedures
- simulator discrepancies and characteristics
- planned use of training controls - Freeze, Reset, Replay, Demonstration, etc.
- communication procedures
- flight plan data

2.2 Brief Simulator Crew

- planned evolution
- support responsibilities
- emergency procedures

III INITIALIZE FUNCTION

3.1 Configure Simulator

- configure simulation system
- configure crew station
- configure IP console

3.2 Initialize Simulator

- enter or verify initial conditions
  - airfield and runway locations, altitudes and arrangement
  - carrier types, positions, speeds, headings, sea state
  - radio/navigation aids locations and characteristics
  - target locations, characteristics and behavior
  - environment - ceilings, visibilities,

temperatures, winds, magnetic variation
- aircraft configuration
- aircraft position and heading (if airborne, altitude, heading, speed, attitude and power)
- malfunctions/failures
- preprogrammed malfunctions/emergencies
- data monitor/record settings

- enter preprogrammed data
- initialize crew station

3.3 Establish Readiness

- student(s) strapped in cockpit
- area secure and safe
- scripts, scenarios, data sheet, etc., available
- make communications check with student and crew

IV TRAIN FUNCTION

4.1 Control Simulator

- activate simulation
- provide interacting man-system simulations per scripts/guides/scenarios
  - controller functions
  - ground crew functions
  - other aircrew functions
  - other vehicles and targets, air, ground, sea, submarine, missiles
  - Radar and early warning system
- activate/deactivate emergencies/malfunctions
- select and activate demonstrations
- set and select replay
- freeze
- initialize and reset
- monitor safety of operations
- deactivate trainer at end of session

4.2 Monitor Performance

- procedures
- technique
- skill level
- simulator performance

4.3 Instruct

- provide feedback

- critique
- correct procedures
- provide technique advice

4.4 Record

- data for feedback
- data for simulator control, i.e., reset, replay
- data for debrief
- data for records

EVALUATE FUNCTION

5.1 Monitor relevant parameter for segment/phase/task
5.2 Establish if performance within training performance envelope
5.3 If performance beyond envelope, diagnose problem
5.4 Select instruction technique to train
5.5 Develop plan and data to implement technique
5.6 Brief simulator crew and student as required

DEBRIEF FUNCTION

6.1 Debrief Student

- organize data collected
- assemble debriefing materials
- review performance problems (replay if available)
- review correct procedures, etc. (demo if available)
- review file data
- outline corrective actions to take

6.2 Debrief Simulator Crew

- review problems
- review overall performance
- discuss simulator discrepancies

I MANAGE DATA FUNCTION

7.1 Student Data

- student grade sheets, training sheets
- simulator training data sheets

7.2 Simulation System Data

- utilization data
- discrepancy data

7.3 Training Data

- problems
- changes tried/proposed
- instruction techniques

VIII DEVELOP SYLLABUS FUNCTION

8.1 Identify Changes
8.2 Format Changes
8.3 Implement Changes
8.4 Validate Changes

IX TRAIN IP FUNCTION

9.1 Simulator Operation

- console familiarization
- console operation
- operating procedures
- syllabus implementation

9.2 Simulator Training

- training functions
- training techniques
- evaluation
- simulator instructing

9.3 Simulator Syllabus Development
9.4 Standardization Training

X SELF/PEER TRAIN FUNCTION

10.1 Basic Simulator IP Function
10.2 Syllabus Lockouts

- preclude "getting ahead of instructor"
- preclude student data file access or change

10.3 Performance Lockouts

- stop training if performance bad or not improving
- stop training if skill overlearned

GLOSSARY

ASW	Anti-Submarine Warfare
IP	Instructor Pilot
IPI	Instructor Pilot Instructor
ISD	Instructional Systems Development
NATOPS	Naval Air Training and Operating Procedures Standardization Program
NAV	Navigation
NFO	Naval Flight Officer
NFOI	Naval Flight Officer Instructor
NTEC	Naval Training Equipment Center
RTS	Readiness Training Squadron
SO	Simulator Operator

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